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Segu Zuhair*
School of Accounting and Finance,
Victoria University,
P.O. Box 14428 MMC,
Melbourne VIC 8001, Australia
E-mail: segu.zuhair@vu.edu.au
*Corresponding author

Riccardo Natoli
Financial Education Research Unit,
Victoria University,
P.O. Box 14428 MMC,
Melbourne VIC 8001, Australia
E-mail: riccardo.natoli@vu.edu.au

Abstract

This paper reviews human capital with special reference to its definition, measurement methods, and its contribution to economic growth and development. Vast amount of effort has been spent on the acquisition of knowledge and its application to enhancing living standards. A formal approach to this topic, however, was developed only during the past 300 years. The increasing importance placed on knowledge, accelerated by the rapid development of information technologies, has necessitated the development of new approaches to assess the role of HC. The increasing role of HC on development is evidenced by the high growth rates achieved by certain resource-poor countries. Sound theoretical framework and measures are required in order to articulate effective policies and assess their impact on growth and development.

Keywords: human capital; economic growth; development.

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1. Introduction

The purpose of this paper is to review the importance of human capital (HC) to economic growth and development of nations. Given that the term HC has been viewed problematic, it is important to establish the historical context from which it came about and how the term has been defined over the years. This will enable the reader to get a greater understanding of the conceptual difficulties. The chapter will then examine the methods employed to measure HC which reflected the definitions that were being utilised by the researcher. Finally, a review of a number of studies assessing the economic impact that HC has had on nations will be undertaken. Throughout this chapter the term *growth* is used in the context of economic growth and development.

Throughout history, advances in civilisation have been linked with the acquisition, development and employment of knowledge, making it an essential contribution to the growth of nations. Its importance is reflected in the long intellectual tradition of employing knowledge sharing functions. For example, in Ancient Greek times Socrates' thoughts were captured by his *protégé* Plato. Other examples include the *Analects of Confucius* and the *The Art of War* by Sun Tzu. All these examples involve the creation, diffusion and utilisation of knowledge (Boorstin, 1983). Despite the historical importance placed on knowledge and its pursuits, the first attempt to fuse humans and monetary evaluation from *both* a theoretical and mathematical level did not occur until 1690 via William Petty. This is the starting point of the present review.

2. An historical overview

As part of the overview, Table I lists the timeline of the significant and influential contributions to the debate on the various aspects of HC. William Petty recognised the importance of labour quality differences. In fact, he claimed that any estimate of national income should include an evaluation of workers. Petty, who had an interest in public finance, favoured a monetary, or income-based, evaluation of labour. Here, the stock of HC was estimated by capitalising the wage bill, which was determined by deducting property income from national income to perpetuity at a 5% interest rate.

According to this method, Petty estimated the total HC stock of England and Wales to be 520 million pounds, or 80 pounds per capita (Le et al., 2003).[1]

Petty's notion was further advanced by Adam Smith who focused on specialised labour, specifically the improvements in production and quality of output that could be attributed to knowledge and skills of employees. Since specialised labour involved the use of scarce inputs (education and knowledge), Smith considered expenditure on education and training to be an investment in human beings. This helped justify higher wages for workers who partook in it. Smith's insight became the basis for future HC theorists (Nerdrum and Erikson, 2001).

Not withstanding the contributions of Petty and later Smith, it was William Farr who in 1853 produced the first truly scientific procedure that estimated the monetary value of a human being (Kiker, 1966). This was then known as capitalised-earnings, currently referred to as the income-based approach.

Table 1 Timeline of prominent HC approaches

Author	*Year*
Petty	1690
Smith	1776
Farr	1853
Engel	1883
Mincer	1958, 1970
Schultz	1961, 1963
Becker	1962, 1964
Machlup	1962
Nelson and Phelps	1966
Kendrick	1976
Eisner	1985
Psacharopoulos and Arriagada	1986, 1992
Romer	1986
Lucas	1988
Jorgenson and Fraumeni	1989, 1992
Barro	1991
Barro and Lee	1993, 2001
Benhabib and Spiegel	1994
Hanushek and Kim	1995
Mulligan and Sala-i-Martin	1997
Bontis	2004

Farr viewed HC as the entire income that could be created by individuals in the labour market over their lifespan. Thus, non-market output was akin to zero value, which made considerations of use-value inappropriate. Specifically, Farr's evaluation technique involved an estimation of the present value of an individual's net future earnings (future earnings minus personal living expenses), with an allowance being made for deaths in accordance with a life table (Kiker, 1966). Employing a 5% discount rate, Farr estimated that the average net HC of an English agricultural labourer was 150 pounds (Le et al., 2003).[2] However, not everyone was enthused about the employment of an income-based measure to estimate HC.

Consequently, in 1883 Ernest Engel produced an alternative which took the form of a cost-of-production approach,[3] which focused on the cost of rearing. Engel employed child-rearing costs from conception to age 25 as an estimate for HC. At 26, Engel considered a person to be 'fully produced' and no longer in need of rearing costs. This estimate could be used as a measure of their monetary value to a nation (Kiker, 1966). Although Engel's approach is less difficult to estimate compared to valuing future earnings, the drawback was associating cost of production to its economic value. These difficulties meant that most economists were reluctant to evaluate human beings, despite acknowledging its importance to growth. For example Alfred Marshall, who perceived investment in human beings as the most valuable of all capital, attempted a capitalised-net-earnings approach before it was ultimately discarded due to its impracticality (Kiker, 1966). Other attempts were made to quantify the actuarial value of employee's knowledge and skills; however these attempts were mostly unfruitful.[4] Consequently, HC analysis virtually lay dormant until its re-emergence in the mid twentieth century through the work of Irving Fisher, whose capital theory defined income and capital in an all-inclusive manner.

"A *stock of wealth* existing at an *instant* of time is called *capital.* A *flow of services* through a *period* of time is called *income."* [Fisher, (1906), p.52] (emphasis in original)

Hence for Fisher, tangible and intangible stock qualified as capital so long as it gave rise to income. Thus, contentious debates regarding the tangible, monetary, durable, and repeatable nature of capital goods was seemingly accounted for. Moreover, it created the platform for theorists to analyse HC in a neoclassical capital theory framework similarly to conventional capital as evidenced by the works of Schultz in the early 1960s and Mincer (1958) (Nerdrum and Erikson, 2001).

Despite different perspectives, both Schultz (who championed investment in HC to increase ones job opportunities and strongly associated education investment with productivity)[5] and before him Mincer (who used investment in education to explain wage differentials) leaned on Fisher's capital theory and considered HC similar to the productive and economic characteristics of 'normal' capital.[6] From this base HC theory rapidly developed, with the most important contribution made by Becker (1962) via a NBER conference paper that introduced the internal rate of return to schooling as a central concept of HC theory. This was followed up in 1964 by his influential: Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education, which equated HC to a physical means of production. All three economists reaffirmed the links between HC and economic growth.

These reaffirmed links meant that the HC concept had become important in explaining earnings differentials and helped make sense of human behaviour at both the individual and social level. Concurrently, the development of neoclassical growth theory, which used Solow's residual as a measure of technological progress equal to the difference between the rate of growth and output, failed to account for a HC framework as an engine of growth.[7] This framework came later with Romer (1986) and Lucas (1988) who proposed the inclusion of technology and knowledge as an essential feature of economic growth, but not as an independent factor of production. This new endogenous growth literature, which aims at examining the reciprocity between tangible and intangible capital, further stimulated HC as a determinant of economic growth (Laroche et al., 1999).

The following historical overview illustrates that:

1. HC is presumed to contribute positively to notions of growth
2. a need exists to devise a measure that will capture it in order to use them in meaningful articulation of policies.

In this light, the next section reviews some of the attempts to measure HC.

3. Approaches to HC measurement

Many different approaches have been taken to measure HC, each with its own strengths and limitations. This section will look at some of the more influential ones. A leading avenue for HC assessment is via the endogenous growth model with two main alternatives. The first belongs to Lucas (1988), who added to what Schultz (1961, 1963) and Becker (1964) defined as HC. Lucas envisioned HC as an individual's general skill level and the approach had the objectives of determining the impact of HC on current production and the impact of time allocation on HC accumulation (Lucas, 1988). In effect, Lucas expanded the concept of capital by treating HC like any other factor of production, where the *unexplained* growth rate was due to differences in the *accumulation* of HC over time. The second, Nelson-Phelps/Romer approach, asserts that the *existing HC stock* of a country determines its ability to replicate and adjust new technologies which ultimately *leads* to sustained growth (Engelbrecht, 2002; Krueger and Lindhal, 2001).[8] For Nelson and Phelps therefore, the key was the role of educated managers, whom they theorised, would make good innovators and speed technological diffusion by introducing new production techniques (Nelson and Phelps, 1966). It seems, therefore, that it is not simply an issue of whether HC does contribute to growth but whether it has the potential to do so. Engelbrecht's (2002) studied compared the two main approaches mentioned above regarding HC and international knowledge spillovers. Engelbrecht found that in most OECD economies, the data, at least to a certain extent, supports both approaches. In fact, as Gundlach et al. (2002) add, HC can enter the production function in many different ways.[9] Nevertheless, the standard growth accounting methodology with HC specified as a factor of production is seen in the following aggregate production function, which can be expressed as:

$$y = f(k, l, h).$$

Here, per capita income, y is dependent upon three input factors: physical capital, k, labour, l, and HC, h (Benhabib and Spiegel, 1994). This approach assumes a Cobb-Douglas technology, expressed as: $y_t = a_t k_t^{\alpha} l_t^{\beta} h_t^{\gamma} \varepsilon_t$ (Temple, 1999). This has the advantage of homogeneity which simplifies modelling cross-country differences. The relationship for long-term growth, via rates of change, can be expressed as:

$$(\ln y_t - \ln y_0) = (\ln a_t - \ln a_0) + \alpha(\ln k_t - \ln k_0) + \beta(\ln l_t - \ln l_0) + \gamma(\ln h_t - \ln h_0) + (\ln \varepsilon_t - \ln \varepsilon_0)$$

This approach however has some serious limitations, particularly regarding the interpretation of the coefficients. Given that HC is an index, the approach of using rate of growth as an explanatory measure must be questioned as it is very difficult to meaningfully interpret an increase in the size of an index in an explanatory model.

Furthermore, Benhabib and Spiegel (1994) employed a standard growth-accounting framework to determine whether a measure of the log change in years of schooling for the workforce in 1965 and 1985 related to the annualised growth rate of GDP. They found a negative coefficient on growth of years of schooling. This result casts doubt on assigning HC as a separate factor of production. Furthermore, they claim that it is the stock of education that matters for growth of total factor productivity due to its ability to adopt and innovate technology quickly (Krueger and Lindhal, 2001) agreeing with Kosempel (2004).

Topel (1999) however, argues that Benhabib and Spiegel's findings result from their log specification of education, while Krueger and Lindhal (2001) found that cross-country regressions indicate that the change in education is positively associated with economic growth once measurement error in education is accounted for. Both Krueger and Lindhal (2001) and Topel (1999) believe that HC is best specified as an exponential function of schooling in a Cobb-Douglas production function. The conjecture surrounding the measurement of HC is not limited to endogenous growth models. Like growth accounting, the evaluative techniques employed for HC in estimates of national wealth are also varied. The present paper will briefly review the three main approaches used in many national wealth estimates.

3.1 The cost-based approach

Although the original proponent of this approach is Engel, what is now regarded as the cost-based method is associated with Schultz (1961) and Machlup (1962) who improved upon Engel's approach. Under this approach, HC is estimated on the assumption that the stock of HC equates to the depreciated value of expenditure on areas considered to be investments in HC, determined of course by the researcher's standpoint (Laroche and Merette, 2006). Nevertheless, the stock of HC is estimated by its inputs. The most influential examples in this field belong to Kendrick (1976) and Eisner (1985). Kendrick estimated the stock of HC to comprise the tangible costs, which mainly included child-rearing costs, up to the age of 14. Intangible investments were also included and dealt with quality enhancement costs such as education and training as well as health and safety (Laroche and Merette, 2006; Aulin-Ahmavaara, 2004). This approach provided a measure of the flow of resources in both educational and other HC related sectors.

Kendrick estimated the USA's yearly national wealth from 1929 to 1969, and found that except for the years 1929 and 1956, the stock of HC comprehensively outperformed physical capital. Kendrick showed that including HC in the national accounts doubled the wealth of the USA (Le et al., 2003). Although the fact that HC doubles wealth may be due to Kendrick's self-fulfilling prophecy, the overriding point of his analysis suggests that any omission of HC constitutes only a partial assessment of wealth.

Eisner slightly modified Kendrick's approach by making some allowances for the valuation of non-market household contributions and including investment in research and development.[10] This modification had the somewhat expected outcome of making Eisner's estimates of HC just below physical capital stocks while Kendrick's were usually above (Le et al., 2003). Apart from this difference Eisner's estimates were are quite similar to that of Kendrick.

There are however, several limitations to these cost-based approaches.[11] One is the failure include distributed lag effects. Here, the summation of historical costs ignores the lengthy gestation period (the time between the input and actualisation embodied in the individual) and the social costs that are invested in people. The other limitations involve alternative theories of value. For instance, the relationship between investment and quality output is seen as too simplistic, since quality is not equal to cost. Critics argue that value is determined by the demand not from its cost. For example, to look after a healthy child costs less than an unhealthy child, thus employing this method will result in an overestimation of the unhealthy child's HC, and an underestimation of the HC of the healthy child. Additionally, for a cost-based measure, the prices employed are not well identified. The lack of existing empirical evidence to identify costs results in a heavy reliance on the assumption of the researcher, particularly with regard to the classification of what constitutes consumption and investment. This can lead to substantial bias in the measure. Moreover, the depreciation rate used significantly impacts on the final estimate of the HC stock. For instance, Kendrick depreciated the HC stock employing a modified double-declining balance schedule, whereas Eisner used the straight-line method. These two approaches ignore HC appreciation which, contrary to the empirical evidence, shows HC appreciating with working experience before depreciating in later life (Mincer, 1958, 1970). Finally, as Jorgenson and Fraumeni (1989) point out, the focus on education and rearing costs ignores the value of non-market activities.

For these reasons, the cost-based method alone should not be seen as an accurate estimation of HC. Given this, the next measurement approach adopts an income-based approach.

3.2 The income-based approach

The income-based approach measures the stock of HC by an individual's remuneration in the labour market via market prices at a discounted value.[12] The employment of market prices is meant to account, to a certain extent, for the other factors that comprise HC in an interactive framework of HC supply and demand. This incorporates aspects such as: professional qualifications, ability and the institutional and technological structures of the economy (Dagum and Slottje, 2000).

For instance, Jorgenson and Fraumeni (1989, 1992) conducted an encompassing income-based measure of HC as pmi of new a system of national accounts, by discounting the value of future incomes earned by HC that comprised *both* market and non-market actions (Aulin-Ahmavaara, 2004). Consequently, non-market activities (except schooling) required an imputation for labour compensation. They were able to show that the size of HC was from 12 to 16 times greater than physical capital. Their 1992 estimate found the USA's HC to be 17.5 to 18.8 times higher than Kendrick's estimation. These figures, and the approach itself, have been criticised.

One such criticism is directed at a key assumption of the approach that differences in wages accurately reflect differences in productivity. However, wages may change for a myriad of reasons, such as reflecting changes in economic rent, leaving a distinct potential for bias. Furthermore, critics have accused Jorgenson and Fraumeni of overestimating the stock of HC due to its handling of non-market activities and setting the retirement age too high at 75. For example, given that non-work time is fully imputed as a non-market activity, there will be no change in HC stock if the labour force was fully employed or only half employed. Thus, unemployment does not affect HC stock (Conrad, 1992). Additionally, the use of school years as a measure of productivity results is biased estimates of future expected earnings, while another shortcoming is that earnings data may not be as widely available as investment data (Le et al., 2003).

In response to the criticisms of the income-based approach, Mulligan and Sala-i-Martin (1997) developed a labour income-based measure of HC for the USA. Rather than adopting a monetary value they arrive at an index value of HC. Hence, HC is measured as the total labour income per capita divided by the wage of the uneducated. Since total labour income incorporates both a worker's skills and the physical capital available to them, workers in industries of higher physical capital will tend to earn more, which Mulligan and Sala-i-Martin claim to result in inaccurate estimates of HC. Therefore, by dividing labour income by the wage of a zero-schooling worker, aggregate physical capital on labour income is accounted for. Thus, workers who possess the same level of education are weighted in proportion to their average wage level. This approach makes the assumption, albeit implicit, that the stock of HC of uneducated workers is identical across time and space even though they may earn different incomes. Since quality of schooling varies, inter-temporal and interregional differences arise; hence the only rational measure is the uneducated worker (Le et al., 2003). May be one way overcome this deficiency is to weight the labour force with differential levels of skills. A distinct advantage of this method is its inclusion of physical capital and how it can allows for the measurement of its impact on labour income. This feature allows the measure to incorporate disparities in the quality of schooling. Furthermore, unlike most other approaches, not only is the elasticity of substitution across workers allowed to vary, but it also does not fix identical sums of skill on workers who share equal years of schooling. Finally, it requires little data for analysis (Laroche and Merette, 2006; Le et al., 2003).

As with Jorgenson and Fraumeni, a limitation of this approach deals with how wages may change for reasons other than reflecting the marginal value of HC. Further, the model greatly relies on the problematic assumptions that totally uneducated workers are indistinguishable and that workers who possess different educational attainment levels are perfectly substitutable (Wachtel, 1997).

Crucially, this measure neglects the impact of large informal sectors due to the absence of wage rates in this field, as well omitting non-formal inputs, such as informal schooling, on-the-job training and health (Jeong, 2002). The failure to capture informal, non-market areas, especially given the rise of the knowledge-based economy, suggest that an income-based method alone would not be able to accurately reflect today's inter-disciplinary conception of HC. The third and final HC approach to review is the output-based approach.

3.3 The output-based approach

The output-based approach employs proxy measures to represent quality of labour input. Much of the current HC research is based on this approach, with the most popular inputs being: *School Enrolment Rates and Adult Literacy Rates.*

School enrolment rates are the gross measure of students enrolled at a grade level relative to the total population of the corresponding age group. Adult Literacy Rates focuses on the ability to read and write at a basic level. Both approaches have been used as proxies for HC in many major studies in an attempt to control HC in cross-country regressions. For the former, the most significant studies are Barro (1991) and Mankiw et al. (1992), whereas for the latter they are Romer (1989) and Azariadis and Drazen (1990). Mankiw et al. (1992) estimated that HC explains 49% and technology 22% of productivity differentials. Worldwide publications such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) Statistical Yearbooks, which publish the relevant data across a number of countries, made this particular approach quite popular, making it easier to conduct empirical work. However, there are some misgivings about the approach.

The output-based measure has been criticised for possessing severe shortcomings, which do not accurately reflect the HC theoretical concept, hence producing unsatisfactory results. For instance, the focus on basic literacy only accounts for the initial stages of HC accumulation. Consequently, other educational investments in HC gained beyond this point, such as scientific and technical knowledge, are omitted, implying that these additions do not significantly add to labour force productivity (Barro and Lee, 1993). On the other hand, school enrolment rates focus on the flow of investments in HC, rather than its stock. This narrow focus only captures a fraction of the continuous accumulation of the stock of HC (Laroche and Merette, 2006). Furthermore, investments in education are quite time-consuming with a long time lag between schooling and future additions to the stock ofHC (Psacharopoulos and Arriagada, 1986). Additionally, the use of gross rather than net enrolment rates, due to greater data availability, is erroneous given that the stock of HC is changed by net additions to the labour force (the difference between the HC embodied in those joining the labour force and those retiring from it). This allows measurement errors related to the possibility that graduates may not participate in the labour force, as well as the presence of grade repetition and dropouts, which is particularly relevant for developing nations (Wobmann, 2003; Barro and Lee, 1993). The limitations of both the adult literacy rate and school enrolment rates as proxies for HC, have led to additional output-based measures such as: *Levels of Educational Attainment and Average Years of Schooling.*

Psacharopoulos and Arriagada (1986, 1992) developed a measure of H C stock that is currently used in production. The measure is based on educational attainment, via the mean years of formal education embodied in the labour force, and has been employed by Barro and

Sala-i-Martin (1995), Barro and Lee (1993), Barro (1997, 2001), Benhabib and Spiegel (1994) and many others. This too has been criticised.

Problems with this approach include issues with data. Since most measures are obtained from census data, which is only performed every five or ten years, data becomes too infrequent to enable rigorous analysis. Also, in some studies, education is only valued if one participates in the labour force, resulting in the HC stock being undervalued, particularly for women (Laroche and Merette, 2006).

Additionally, by specifying HC as average years of schooling it implies that the productivity differentials among workers are proportional to their years of schooling. For instance, an individual with six years of schooling is six times more productive than an individual with one year of schooling. According to the work of Psacharopoulos (1994), this disregards microeconomic literature which shows decreasing returns to schooling. Such an interpretation however, depends on the size of the coefficient in the regression equation. Of course, any system which assigns the same weight to a year of schooling no matter the school system fails to take into account issues of educational quality over time, such as: teaching, curriculum, infrastructure, student to teacher ratio, etc. (Wobmann, 2003).

These omissions highlight the importance of the need for more comprehensive measures. In developing such a measure, Wobmann (2003) argues that two vital features of HC specification need to be acknowledged, and if possible, incorporated to help avoid biased estimates of HC. They are: an accurate assessment of rates of return to education and quality of education. Wobmann declares that data on international differences in quality of education adds a large amount of extra information into the HC measure. In fact Wobmann (2002) illustrates that when original education quality data is employed the HC share rises significantly, for instance to 5 I% in a study of 38 countries. Thus, the development impact of HC is underestimated by previous HC specifications as well as misreported data.

As mentioned in the previous section, since Mincer (1958, 1970) and, despite some variations, for instance Becker (1962, 1964), countless studies assess the log earnings and report estimated coefficients.[13] Another one belongs to Ashenfelter and Rouse (1999) who assessed returns to education and concluded that additional years of schooling increased the future financial returns to education. In effect, possessing a degree earns a person a higher income over life time, even if the starting wages may be lower on a age wise comparison. Another issue not dealt with is the trade-off between school and other activities, whether it is labour or leisure. One study conducted by Heckman et al. (2006), concluded that the large estimated psychic costs of schooling was one explanation for non-attendance at school despite the incentive of greater financial rewards.

Bils and Klenow (2000) attempted to incorporate the rate of return; however problems of data availability, specifically the failure to assess ability and social benefits gave the measure a bias that led to it carrying more noise than information (Barro and Lee, 2001). Attempts have also been made to assess quality of education, such as Barro (1991) who used student-teacher ratios as a proxy for quality of schooling. Then in 1995, Barro teamed up with Sala-i-Martin to employ a government-spending ratio on education to GOP (Barro and Sala-i-Martin, 1995). A year later, Barro and Lee (1996) expanded this notion to include educational expenditure per student, student-teacher ratios, teacher salaries and length of school year. In 2001, Lee and Barro added family inputs to the list, which proved to be a strong determinant of educational quality.

Interestingly, a study conducted by Hanushek and Kim (1995) that focused on test scores as the outcome measure, found that proxies for quality such as teacher-to-pupil ratio or resources expended per student did not possess significant correlation to results. This has since been reinforced by many other studies (Hanushek and Kimko, 2000). One reason given for this poor result is that quality of education is heavily influenced by differences in institutional features, such as educational infrastructure (Wobmann, 2003). An alternative lies in the direct measure of individuals' cognitive skills, which can be assessed via the results of standardised international tests of student achievement in mathematics and natural sciences (Gundlach et al., 2002).

Scoppa (2007) adjusted for quality using Gundlach et al. (2002) 'development accounting' methodology. When using years of education among the labour force for rates of return not far from plausible world averages, the role of HC in explaining Italian regional differences is around 20% to 25%. Using decreasing marginal return on schooling- instead of a constant rate of return on schooling- HC becomes less important in explaining development (11.1%). When HC is measured by years of education, it explains I 5% of Italian regional development differentials. When corrected for the effective quality of labour force skills HC can explain almost half of the difference in the levels of development, becoming the most important production factor. According to Scoppa's (2007) study, which used the variance decomposition methodology, HC accounts for 16% of the differences in output per worker across Italian regions.

According to the estimates of Ciccone and Papaioannou (2006), who measure levels of HC using schooling quality indicators, the growth differential is 1.3% to 2.1% higher in a country with schooling quality at the 75 percentile than a country with schooling quality at the 25 percentile. Furthermore, when they used average years of schooling as a proxy for HC levels, the growth differential is 1.1% to 1.8% greater in countries at the 75 percentile than countries at the 25 percentile. Furthermore, the employment growth differential in HC intensive industries, when schooling quality is used as a proxy for HC levels, is 2% greater in countries at the 75 percentile than countries in the 25 percentile. These improvements are similar or larger than the differential growth effects of financial development and property rights protection.

The varied approaches suggest that there exists a myriad of ways to define and measure HC, all dependent on the researcher's intent. HC is a concept that encompasses many dimensions and acquiring points making it quite a complex phenomenon. Some of the aspects contributing to this complexity are: since it is embodied in humans it is non-tradable, except in the case of slavery; it has both qualitative and quantitative aspects; it can be either general or specific; and it contains external effects from the social environment and the institutional context in which they live, which continually shapes its acquisition (Laroche et al., 1999).

Given the rapid onset of information technologies, and the increasing importance of knowledge, new methods for the evaluation of intangible assets as well as the tangible aspects of process and outcome are needed. So much so, that leading researchers specialising in the knowledge economy are of the opinion that current HC specification alone, no matter which approach one takes, cannot accurately identify and assess developments in the field. At best, it is seen as a partial measure. This reasoning has led to the creation of IC measurements.

4. Intellectual capital as part of HC measurements

The introduction of knowledge into products and services has given labour an entirely different slant, as observed below.

“In contrast to the majority of labour before, which was simple and routine, now the majority of labour is tied to knowledge and the ability of the employees to transform it into profitable action.” [Pulic, (2000), p. 703]

The rapid pace of current technological breakthroughs has altered the traditional balance of the economy. This has enabled traditional capital, land and labour poor countries the opportunity for increased levels of (economic) growth via an emphasis on knowledge and innovative production (Kahin, 2006).[14] This is best illustrated in the cases of Singapore, Taiwan and Hong Kong who have achieved higher levels of growth without the advantages of natural resource endowments (Abdulai, 2001).

Given the potential importance of knowledge to society, a measurement is required to ensure it is managed appropriately. Consequently, interest in IC measures is at its peak. However, like HC, the characteristic of IC makes it quite difficult to measure. Not surprisingly, concerns have arisen as to whether macroeconomic statistics can accurately trace the changes in the information society (Van Ark, 2002). Despite the vast majority of IC frameworks resulting from an accounting and financial perspective at the firm level, these concerns eventually led IC theorists to expand the concept to incorporate nations, which led to the onset of national IC measurements. Here, the IC of a nation consists of:

> "the hidden values of individuals, enterprises, institutions, communities and regions that are the current and potential sources for wealth creation." [Bontis, (2004), p.l4]

For Bontis (2004), Andriesson and Starn (2005), and many others, national IC measurement is addressed through a list of indicators based on the Skandia Navigator IC common nomenclature (Hervas-Oliver and Dalmau-Porta, 2007),[15] where the IC of a nation consists of HC as well as structural capital.[16] In essence, structural capital is the supportive infrastructure of HC, assisting a nation to own and utilise knowledge resources. It encompasses legal rights of ownership, technologies, inventions and publications as a means to transform knowledge into explicit knowledge measured by its benefit or value to society (Bontis, 1998; Sullivan, 1999).

Hence, national IC measurements based on the Skandia Navigator employ four key constructs, they are: HC (which was reviewed earlier); process capital; market capital; and renewal capital.[17] Any omission of IC, it is argued, would lead to a severe underestimation of the HC contribution to the (economic) growth of a nation via the traditional HC measurement approach.

Reflecting the broader approach, Athreye (2005) who examined the role of the IT industry in India found a significant role, with IT accounting for over 28% of GDP growth between 2000 and 2002. A study by De and Dutta (2007) designed a used a model of a 'new economy' production function that has both tangible and intangible inputs. It employed wages to represent HC. The estimates indicated that organisational capabilities and HC have a large and significant effect on output. The elasticity of output to changes in HC is of the order of 0.18. Previously, IT studies used investments in hardware and software, here De and Dutta (2007) demonstrate that the key element of IT -driven productivity growth is organisational capital.

5. Conclusions

This paper provided an historical overview of the HC concept, from which the complexities surrounding the measurement of HC were highlighted. This paper also illustrated the varied measurement approaches and outlined the effects that HC- and to a lesser extent, IC- has had on the growth of countries, regions across countries and within certain industries. The measurement of HC still has a long way to go, this is reflected by the fact that most official national statistical offices are still somewhat reluctant to measure this area - and when they do their findings are quite circumspect.

It is clear then that HC comprises knowledge and skills which is essential for sustainable development. Some countries experience resource-based growth at their early stages of development but tend to stagnate if this is not closely followed by productivity based development. HC plays a vital role in the continuous improvement in total factor productivity.

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Notes

[1] As Kiker (1966, p.482) points out, Petty's attempt to place a monetary value on human beings was met with some astonishment. For example, Dean Swift cynically satirised Petty in his *'A Modest Proposal for Preventing the Children of Poor People from Being a Burden to Their Parents or the Country'*.

[2] This amount was the difference between the average salary of 349 pounds, and the average maintenance cost of 199 pounds [Le et al., (2003), p.277].

[3] This was later to become known as the cost-based method.

[4] Many economists considered the HC concept, far too many to mention here. The more prominent include: Dublin and Lotka, Jean Baptise Say, John Stuart Mill, Frederich List, Nassau Senior, J.R. McCulloch, Henry D. Macleod, A. Barriol and Leon Walras. A discussion of this can be found in Kiker (1966, pp.481-499). Additionally, a summary of studies on measuring HC, from Petty onwards can be found in the Appendix section of Le et al. (2003).

[5] Schultz established the link while examining the reasons for Gennany and Japan's speedy post Second World War recovery.

[6] According to Nerdrum and Erikson (2001, p.l29), Schultz approached HC on a macroeconomic level whereas Mincer's approach was on a microeconomic level.

[7] Growth accounting analyses the relationship between factor use and output that is based on a production function presented in 1928 in a seminal article titled, 'A Theory of Production', by C. Cobb and Douglas.

[8] Nelson and Phelps (1966) were the first to model this hypothesis. The view that individual productivity can be affected by the HC in the economy is also prominent in Jacobs (1966).

[9] For instance, Mankiw et al. (1992), along with numerous empirical studies, employ HC as an ordinary input in the production function proxied by average years of schooling. Benhabib and Spiegel (1994) model HC as facilitating adoption of technology from abroad and creating appropriate domestic technologies rather than incorporating HC as a factor of production. Alternatively, Bils and Klenow (1998) model the macroeconomic stock of HC based on semi-logarithmic relation between income and average years of schooling (microeconomic Mincerian wage equation), which has been adapted to model the macroeconomic stock of HC. A summary of the above can be located in Gundlach et al. (2002).

[10] Le et al. (2003, pp.274-276) Kendrick divided the investments in HC into tangible and intangible components, whereas Eisner classified all HC investments as intangibles.

[11] The main limitations presented here are a summary of Le et al. (2003, pp.274-275), and Laroche and Merette (2006, pp.3-4).

[12] The origins of the measure rest with William Petty and William Farr (Kiker, 1966).

[13] In fact, many scholars refer to it as the •Mincer rates of return'.

[14] Of course, this also applies to traditionally 'rich' countries as well.

[15] Other national IC measurements can employ national competitiveness partially explained by IC components such as the Global Competitiveness Index, while another avenue is to employ a non-IC Skandia common nomenclature, The latter though is used more for a regional analysis (Hervas-Oliver and Dalmau-Porta, 2007).

[16] Structural capital consists of market capital and organisational capital, from which organisational capital is then split into process capital and renewal and development capital [Malhotra, (2003), p.23].

[17] The national view ofiC is only in its infancy. The more prominent national IC analyses are: Rembe (1999), Pasher (1999), Bontis (2004), Andriesson and Starn (2005) and Edvinsson and Bounfour (2005). In the 1980s Karl-Erik Sveiby, began an investigation that produced the first analysis of the

nature of IC, but it applied to organisations and not nations. For a review of the main IC components please refer to Bontis (2004).